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Building Performance

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Building Performance

by
Aaron Kenneth Wong
A Terminal Project
Presented to the Faculty of
The College of Architecture at the University of Nebraska
In Partial Fulfillment of Requirements
For the Degree of Master of Architecture
Major: Architecture
Under the Supervision of Professor Nate Krug
Lincoln, Nebraska
May, 2010
This project is a critique on current sustainable practices and looks to create a better system for sustainability that can build upon itself, serve as a progressive system for future use, and ultimately offer a means for self sustaining cities. The current standards for sustainability are far from being progressive or even par for current needs. The means in which buildings are evaluated and means in which sustainability is thought of is very limited, and has lost site of fundamental goals. A new system in which sustainability is not thought of on as a one off building, but on a city wide system is needed.

The performing arts center will serve as a prototype for the new sustainability system, which will not only be used as a catalyst to inject life back into the south Haymarket area, but also as the technological and sustainable standard for future performing arts centers. The current working habits and energy consumption of performing arts centers and other similar building types fail to even register on the current sustainability scale. It is not only our duty as architects but as admirers of the arts to help preserve them. The fact that most performing arts centers and convention centers seem to be exempt from the basic standards of sustainability is ludicrous.

In creating an educational pilot program in the south Haymarket neighborhood, it will create not only public interest in the area which will be key in the rejuvenating the area. The disjunction between the buildings ability to perform as its ability to work as a contributing member of the city is a key concern in this project.
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“If you look at the difference between Europe and the US in terms of energy consumption, it’s almost all accounted for with human settlement pattern and the availability of transit… We’re completely in favor of energy efficient light bulbs, thermal windows - these things are all spreading and being used like crazy. But human settlement is the one big thing that would really change things - the one big thing that hasn’t been popularly embraced.”

-John Norquist
As the United States and its cities have taken shape there have been many factors that have helped contribute to the way that American cities have developed in the way they have. The two most influential things that have affected where we live and how we do it, is the invention of the car and air conditioning. The freedom of mobility that the car has allowed Americans has caused American cities to spread wider than most European cities. In spreading the urban fabric so wide, it has only exacerbated American's dependencies on both the car but on fossil fuels.

Air conditioning has allowed people around the world to live in places that they would otherwise deem inhospitable. In allowing people such freedom to live anywhere, many cities have developed in places that can not support the population that has decided to live in the area.
Phoenix Arizona and Los Angeles are perfect examples of the influence that air conditioning and cars have had on the way American’s have not only developed the cities they live in, but also the locations in which they live. Phoenix was forced to create the Central Arizona Project aqueduct because of the region’s inability to provide enough water for the population that wanted to live in this arid desert climate. The Central Arizona Project supplies the city with the majority of the city’s water. The system pumps use the equivalent electricity as 210,000 Arizona households, pumping the needed water uphill. The Navajo Generating System whose majority of energy produced goes to pumping water 336 miles, was built just to feed the energy needs for the water pumps.
Los Angeles has a similar issue with the availability of water in the area. The city pipes water through the Los Angeles Aqueduct over hundreds of miles over fault lines and mountains. A redeeming factor to this massive installation of infrastructure is that on the downhill sides of water pumping, the system generates electricity to help offset the amount of energy being consumed in this almost monolithic undertaking.

While the population of the world as a whole has continued to grow, so has the amount of resources consumed. The only problem with this constant state of progress is that the amount of resources available remains unchanged. Americans remain some of the biggest culprit in the world in regards to energy consumption per capita. Americans consume twice as much energy per capita as the British, six times more then the Chinese and eleven then a Salvadoran.
### Sustainable Metrics:

<table>
<thead>
<tr>
<th>Metric</th>
<th>1970</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Population</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Energy Consumption</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Energy Consumption per capita</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Oil consumption</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of world oil production (U.S.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of world oil production (China, India, &amp; Brazil combined)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fossil Fuel per capita</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Renewable Energy consumption</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Renewable energy per capita</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cost of Gasoline</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Registered automobiles</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Domestic air miles</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1970</strong></td>
<td>203m</td>
<td>308m</td>
</tr>
<tr>
<td><strong>Energy Consumption</strong></td>
<td>67.8 trillion BTUs</td>
<td>94.6 trillion BTUs</td>
</tr>
<tr>
<td><strong>Energy Consumption per capita</strong></td>
<td>.333 million BTUs/person</td>
<td>.307 million BTUs/person</td>
</tr>
<tr>
<td><strong>Oil consumption</strong></td>
<td>.07 bbl/day/person</td>
<td>.06 bbl/day/person</td>
</tr>
<tr>
<td><strong>% of world oil production (U.S.)</strong></td>
<td>27%</td>
<td>23%</td>
</tr>
<tr>
<td><strong>% of world oil production (China, India, &amp; Brazil combined)</strong></td>
<td>5%</td>
<td>16%</td>
</tr>
<tr>
<td><strong>Fossil Fuel per capita</strong></td>
<td></td>
<td></td>
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<tr>
<td><strong>Renewable Energy consumption</strong></td>
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<td><strong>Renewable energy per capita</strong></td>
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<tr>
<td><strong>Registered automobiles</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Domestic air miles</strong></td>
<td></td>
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</tr>
<tr>
<td><strong>1970</strong></td>
<td>.066 trillion BTUs/person</td>
<td>.083 trillion BTUs/person</td>
</tr>
<tr>
<td><strong>Energy Consumption</strong></td>
<td>2.6 trillion BTU/person</td>
<td>4.3 trillion BTU/person</td>
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<tr>
<td><strong>Energy Consumption per capita</strong></td>
<td>.012 trillion BTU/person</td>
<td>.014 trillion BTU/person</td>
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<tr>
<td><strong>Oil consumption</strong></td>
<td>$.36/gal</td>
<td>$4.00/gal</td>
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<tr>
<td><strong>% of world oil production (U.S.)</strong></td>
<td>108 million</td>
<td>246 million</td>
</tr>
<tr>
<td><strong>% of world oil production (China, India, &amp; Brazil combined)</strong></td>
<td>117,542 million</td>
<td>583,506 million</td>
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<tr>
<td><strong>Fossil Fuel per capita</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Renewable Energy consumption</strong></td>
<td></td>
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</tr>
<tr>
<td><strong>Domestic air miles</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Scott Simpson’s “Going Green: Taking the Long View” in Design Intelligence, July/August 2011.
Energy Consumption per Capita

The United States uses twice as much energy per capita than a Briton, six more than a Chinese and eleven more times than a Salvadoran.
Dr. Adam Neiman’s diagram depicting all of the water in the world in relation to the mass of the world and all of the atmosphere in the world in relation to mass.

http://imageshack.us/photo/my-images/131/vlcsnap10279861lv9.png/sr=1
<table>
<thead>
<tr>
<th>Site Selection and Development</th>
<th>Energy Efficiency</th>
<th>Water Conservation</th>
<th>Material and Resource Efficiency</th>
<th>Indoor Environmental Quality</th>
<th>Additional Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Energy Star for Buildings and Plants</th>
<th>Green Globes</th>
<th>LEED-NC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Selection and Development</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Energy Efficiency</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Water Conservation</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Material and Resource Efficiency</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Indoor Environmental Quality</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Project Management; Emissions</td>
<td>Innovation in Design; Regional Priority</td>
<td></td>
</tr>
</tbody>
</table>
LEED:
Most well known certification means in US

Green Globes:
Offers cradle-to-grave calculator

Energy Star:
U.S. EPA and Department of Energy
Compared against comparable building types

National Green Building Standard

Local and Regional Programs

Ecological Performance Standards (HOK)
### LEED

**Criteria**
- Sustainable Site - 26 pts
- Water Efficiency - 10 pts
- Energy Atmosphere - 35 pts
- Materials and Resources - 14 pts
- Indoor Environmental Quality - 15 pts
- Innovation in Design - 6 pts
- Regional Priority - 4 pts

**Level of Certification**
- Certified - 20 - 49 pts
- Silver - 50 - 59 pts
- Gold - 60 - 79 pts
- Platinum - 80 - 100 pts

### GREEN GLOBES

**Criteria**
- Project Management - 50 pts
- Site - 115 pts
- Energy - 380 pts
- Water - 85 pts
- Resources - 100 pts
- Emissions, Effluents & other Impacts - 70 pts
- Indoor Environment - 200 pts

**Level of Certification**
- 5 Globes - 85 - 100%
- 4 Globes - 70 - 84%
- 3 Globes - 55 - 69%
- 2 Globes - 35 - 54%
- 1 Globe - 15 - 34%

### ENERGY STAR

**Criteria**
- Project Management - 50 pts
- Site - 115 pts
- Energy - 380 pts
- Water - 85 pts
- Resources - 100 pts
- Emissions, Effluents & other Impacts - 70 pts
- Indoor Environment - 200 pts

**Level of Certification**
- 5 Globes - 85 - 100%
- 4 Globes - 70 - 84%
- 3 Globes - 55 - 69%
- 2 Globes - 35 - 54%
- 1 Globe - 15 - 34%
The current means in which we measure and implement sustainability in buildings leaves much to be desired. While there are a variety of different standards and means in which we do this, each having its merits, there remains major holes in the application and scope of the work.

LEED:
Highly Political
Disconnect between its emphasis on point allocation and actual environmental benefit.

Green Globes:
Most Adaptable to design conditions
Not well known
Bases rating on an end percentage instead of total points

Energy Star:
Narrow scope of Sustainability
Easy and uncomplicated to apply for

Local and Regional Programs
Varies city to city and inconsistent across the board

Ecological Performance Standards (HOK)
Building must be as efficient as ecosystem it is replacing
Still in the works
With systems like Green Globes, LEED and Energy Star in place it would be logical to assume that most buildings would be pushing to meet or exceed past current standards. Upon further investigation it has been found that the less than twenty five percent of the polled firm’s projects are being designed to meet or exceed LEED Gold standards. This small percentage is rather shocking considering the current emphasis that Americans have put on the issue.
The cost of construction and cost of design are the two leading factors that are perceived to impede higher levels of building sustainability. The only problem with this perception is that over the life span of a building the total cost difference is one and a half percent. So with the cost difference being so minimal there really is no reason for our current sub par sustainability standards.

<table>
<thead>
<tr>
<th>Factors that affect firm’s ability to achieve higher levels of building performance/sustainability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client Demand</td>
</tr>
<tr>
<td>Client Perceptions/Expectations</td>
</tr>
<tr>
<td>Regulations</td>
</tr>
<tr>
<td>Cost of Design</td>
</tr>
<tr>
<td>Cost of Construction</td>
</tr>
<tr>
<td>Cost of Building Operation/Maintenance</td>
</tr>
<tr>
<td>Available Technology</td>
</tr>
<tr>
<td>Available Materials</td>
</tr>
</tbody>
</table>

The cost difference to design, construct, or operate a sustainable or high-performance building compared to traditional methods?

- Median cost difference to design a sustainable or high-performance building: 5%
- Median cost difference to construct a sustainable or high-performance building: 1.5%
- Median cost difference to operate a sustainable or high-performance building: -5%
Wind:
- 6 Million Homes (world)
- 1.6 Million Homes (U.S)
- 25 Million homes (2025)

Water:
- Hydroelectricity
  - 289.25 Billion Kilowatt hours (U.S)
  - 22.4% is produced by the U.S
  - 6.54% of U.S. use hydroelectric power
- Cooling/Heating
  - Heat exchange

Geo Thermal:
- Heat Pumps
  - Available all over the world
- Energy Pumps
  - Binary Cycle Power
  - Flash Steam Power
  - Dry Steam Power
  - 4 million people use it (US)
  - 60 Million in the world

Plant Gardens
- Water Retention
  - Reducing site run off
- Living Machine
  - Filtering waste water
  - Native plant life
  - Using plants that need minimum care.

Energy:
- Kinetic Energy
Solar:
Concentrated Solar Power
more efficient
Photovoltaics
Semi-transparent
Higher efficiency
Accounts for .01% of the total use in the world
10,000 times more solar energy comes to the earth than we use in all other power types.

Proto Pearl
Paint that captures carbon and makes it into a limestone like skin,

Proto Cell Technology:
- Chemically Engineered metabolic materials that create a limestone like construction.

Fab Tree Hab:
- Pleaching “Tree Grafting” Homes
- 7-10 years to Grown
- 50% living home design

Eden Project
- Pressurized membranes
- ETFE (1% of double glazing)
- Saving on Footings and Steel

Card board to Caviar Project
- Closed Loop System

Novacem
- Concrete using Co2 to make concrete.
While no one form of alternative energy offers a silver bullet answer to the current energy troubles, their use in tandem can help to help alleviate some of them. Each alternative energy source has its perks as well as its disadvantages.

Nebraska, Solar energy and surface meteorology

<table>
<thead>
<tr>
<th>Variable</th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>M</th>
<th>J</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insolation, kWh/m²/day</td>
<td>1.90</td>
<td>2.58</td>
<td>3.55</td>
<td>4.53</td>
<td>5.35</td>
<td>6.16</td>
<td>6.20</td>
<td>5.35</td>
<td>4.39</td>
<td>3.11</td>
<td>2.04</td>
<td>1.64</td>
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<tr>
<td>Clearness, 0 - 1</td>
<td>0.48</td>
<td>0.47</td>
<td>0.47</td>
<td>0.48</td>
<td>0.49</td>
<td>0.53</td>
<td>0.55</td>
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<td>0.53</td>
<td>0.50</td>
<td>0.46</td>
<td>0.46</td>
</tr>
<tr>
<td>Temperature, °F</td>
<td>20.6</td>
<td>25.3</td>
<td>36.3</td>
<td>49.5</td>
<td>61.1</td>
<td>69.6</td>
<td>73.8</td>
<td>72.5</td>
<td>63.5</td>
<td>51.2</td>
<td>35.4</td>
<td>23.7</td>
</tr>
<tr>
<td>Wind speed, MPH</td>
<td>14.2</td>
<td>14.1</td>
<td>15.6</td>
<td>16.2</td>
<td>14.4</td>
<td>13.0</td>
<td>11.7</td>
<td>11.6</td>
<td>12.3</td>
<td>12.3</td>
<td>13.7</td>
<td>13.7</td>
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<tr>
<td>Precipitation, in</td>
<td>0.56</td>
<td>0.73</td>
<td>2.11</td>
<td>2.71</td>
<td>3.96</td>
<td>3.97</td>
<td>3.24</td>
<td>3.45</td>
<td>3.51</td>
<td>2.14</td>
<td>1.26</td>
<td>0.87</td>
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<tr>
<td>Wet days, d</td>
<td>5.6</td>
<td>5.5</td>
<td>8.3</td>
<td>9.4</td>
<td>11.1</td>
<td>8.4</td>
<td>8.2</td>
<td>8.8</td>
<td>8.1</td>
<td>6.6</td>
<td>5.7</td>
<td>5.9</td>
</tr>
</tbody>
</table>
## Solar Panel Comparison

<table>
<thead>
<tr>
<th>Model</th>
<th>Size of Panel</th>
<th>Efficiency</th>
<th>Total Energy Produced in a Year</th>
<th>Estimated Cost</th>
<th>Annual Energy Saving at $.12/kWhr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kyocera - KD-205GX-LP</td>
<td>31” x 59”</td>
<td>0.14</td>
<td>295 kWhr/year</td>
<td>$830.25</td>
<td>$35</td>
</tr>
<tr>
<td>Kyocera - KD-180GX-LP</td>
<td>39” x 52”</td>
<td>0.16</td>
<td>374 kWhr/year</td>
<td>$720.72</td>
<td>$45</td>
</tr>
<tr>
<td>Sanyo - HIT Power 205</td>
<td>34.6” x 51.9”</td>
<td>0.18</td>
<td>367 kWhr/year</td>
<td>$1339</td>
<td>$45</td>
</tr>
<tr>
<td>Sanyo - HIP-195BA3</td>
<td>34” x 52”</td>
<td>0.18</td>
<td>367 kWhr/year</td>
<td>$830.25</td>
<td>$44</td>
</tr>
<tr>
<td>Sanyo - HIP-200BA19</td>
<td>34” x 52”</td>
<td>0.18</td>
<td>367 kWhr/year</td>
<td>$1562</td>
<td>$44</td>
</tr>
<tr>
<td>Solar World - Sw175</td>
<td>31” x 62”</td>
<td>0.14</td>
<td>310 kWhr/year</td>
<td>$1215</td>
<td>$37</td>
</tr>
<tr>
<td>Uni Solar - UNI-Solar 64w</td>
<td>28” x 53.8”</td>
<td>0.06</td>
<td>104 kWhr/year</td>
<td>$389</td>
<td>$12</td>
</tr>
<tr>
<td>Uni Solar - PVL 136</td>
<td>15.5” x 216”</td>
<td>0.06</td>
<td>232 kWhr/year</td>
<td>$697</td>
<td>$28</td>
</tr>
<tr>
<td>Generic Amorphous</td>
<td>24” x 48”</td>
<td>0.06</td>
<td>80 kWhr/year</td>
<td>$400</td>
<td>$10</td>
</tr>
<tr>
<td>Generic Polycrystalline</td>
<td>24” x 48”</td>
<td>0.15</td>
<td>199 kWhr/year</td>
<td>$801</td>
<td>$24</td>
</tr>
<tr>
<td>Sharp - ND - 208U1F</td>
<td>39” x 65”</td>
<td>0.128</td>
<td>374 kWhr/year</td>
<td>$1584</td>
<td>$45</td>
</tr>
<tr>
<td>Sharp - NT - 175UC1</td>
<td>32” x 62”</td>
<td>0.14</td>
<td>320 kWhr/year</td>
<td>$950.27</td>
<td>$38</td>
</tr>
<tr>
<td>Sun Tech - STP1805-24/Ab-1</td>
<td>31” x 62”</td>
<td>0.16</td>
<td>355 kWhr/year</td>
<td>$849</td>
<td>$43</td>
</tr>
<tr>
<td>Evergreen - ES-B-180</td>
<td>37” x 62”</td>
<td>0.14</td>
<td>370 kWhr/year</td>
<td>$877</td>
<td>$44</td>
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<tr>
<td>BP Solar - BP175B</td>
<td>31” x 62”</td>
<td>0.15</td>
<td>333 kWhr/year</td>
<td>$1172.08</td>
<td>$40</td>
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<tr>
<td>GE - GEPV200</td>
<td>38” x 58”</td>
<td>0.14</td>
<td>356 kWhr/year</td>
<td>$1618.24</td>
<td>$43</td>
</tr>
</tbody>
</table>

http://www.wunderground.com/calculators/solar.html
Average Rainfall Map for the state of Nebraska.

http://www.eldoradocountyweather.com/climate/us-states/States-Rainfall-Maps/Nebraska.png
Nebraska city precipitation totals

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Island</td>
<td>25.89</td>
<td>30.6</td>
<td>87</td>
<td>46</td>
<td>3</td>
</tr>
<tr>
<td>Lincoln</td>
<td>28.37</td>
<td>28.4</td>
<td>93</td>
<td>46</td>
<td>2</td>
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<tr>
<td>Norfolk</td>
<td>26.66</td>
<td>30.1</td>
<td>91</td>
<td>50</td>
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</tr>
<tr>
<td>North Platte</td>
<td>19.66</td>
<td>29.8</td>
<td>84</td>
<td>46</td>
<td>3</td>
</tr>
<tr>
<td>Omaha</td>
<td>30.22</td>
<td>30.5</td>
<td>99</td>
<td>46</td>
<td>3</td>
</tr>
<tr>
<td>Scottsbluff</td>
<td>16.33</td>
<td>41.2</td>
<td>87</td>
<td>45</td>
<td>4</td>
</tr>
<tr>
<td>Valentine</td>
<td>19.52</td>
<td>33.6</td>
<td>83</td>
<td>76</td>
<td>3</td>
</tr>
</tbody>
</table>

Nebraska Annual Precipitation - 23.63 inches, 38th wettest state in the U.S.

Nebraska Annual Rainfall and Climate Data
http://coolweather.net/staterainfall/nebraska.htm
New Geothermal Technology

Low Temperature Hydrothermal -
Energy is produced from areas with naturally occurring high fluid volumes at temperatures ranging from less than boiling to 150°C (300°F). This application is currently producing energy in Alaska, Oregon, Idaho and Utah.

Geopressure and Coproduced Fluids Geothermal-
Oil and/or natural gas are produced together with electricity generated from hot geothermal fluids drawn from the same well. Systems are installed or being installed in Wyoming, Both Dakotas, Utah, Louisiana, Mississippi and Texas.

Enhanced Geothermal Systems (EGS)-
Areas with low fluid content, but high temperatures of more than 150°C (300°F), are “enhanced with injection of fluid and other reservoir engineering techniques. EGS resources are typically deeper than hydrothermal and represent the largest share of total geothermal resources capable of supporting larger capacity power plants.

-Science Daily
NEW SUSTAINABLE SYSTEM
Sustainable food production has become a market in and of itself. Yet the local scale has been neglected. The smaller scale food production is far more sustainable not only from an economic level but an environmental one.

- Efficiency based on square footage as well as production

Food Production

Fruits/Vegetables

Cattle/Swine

Fish

Poultry
The way in which we dispose of waste now is incredibly inefficient. There are easy means in which we can not only cut down on waste, but also create opportunities for growth and increased resources.

- Efficiency is based on reuse, waste management, and percentage of existing materials reused in construction.
Arguably, water is the most important resource in the world. Its conservation and treatment is imperative for future use. Current standards for water efficiency are sub par. Practices in this area remain relatively small scale.

- Efficiency Based square footage as well as usage

- Bioswale/Rain Garden
- Rain/Graywater Collection
- Porous Pavement
- Green Roof
- Geothermal Heating
As the dependency on fossil fuel continues to grow, need for more efficient means of energy production are necessary. Our dependency on fossil fuel permeates every aspect of our life and as the price of crude oil continues to go up, it will exponentially impact the cost of living.

- Efficiency is based on a percentage of surplus produced v.s. usage as well as square footage.

Energy Production

- Biomass
- Solar
- Geothermal
- Wind
- Tidal/Wave Power
- Nuclear
Sustainability Matrix:

Each new development will have an emphasis, a specialization of the matrix such as power, food production, etc. From there, each building within the development will pick and choose from the other criteria, determining which characteristics best suit their building type. Each building must meet at least one criteria of each of the categories that are not the development’s emphasis. Some concessions will be given based on location, laws and other constraints.
Energy Production
- Biomass
- Solar
- Geothermal
- Wind
- Tidal/Wave Power
- Nuclear

Water Use
- Bioswale/Rain Garden
- Geothermal Heating
- Green Roof
- Porous Pavement
- Rain/Graywater Collection

Food Production
- Fruits/Vegetables
- Fish
- Poultry
- Cattle/Swine

Waste Management
- Brown Field
- Material Reuse
- Yard/Bio Waste
- Recycling

NEW SUSTAINABLE SYSTEM
Large Scale Application:
The ability to implement this system on a large scale is imperative to the overall sustainability of a city. Different areas of the city will be designated a specific criteria in which they will excel. The criteria areas will be decided by considering existing building use, zoning, topography and availability of resources. Each region will be expected to excel in their criteria in order to make up for the possible deficiencies that other regions in the city may have.
NEW SUSTAINABLE SYSTEM
Lincoln Master Plan

Guiding Principles

- Enhance Retail
- Improve Bicycle System
- Provide Additional Open Space
- Enhance Aesthetics
- Improve Parking
- Address Traffic
- Provide New Shuttle Services
- Improve Transit Usage
- Enhance Pedestrian Safety

Eden Project Domes
Lincoln Master Plan

- City’s “living room”
- New, centrally located public open space.
- Primary Retail Anchors
- West Haymarket Civic Development
  Mixed use housing development
- New Arterial Loop Road
  Grid of streets within the existing rail yards
- New North South “couplet” between P and Q.
- Proposed South Haymarket Park
  Reclamation of old industrial sites
- Primary Pedestrian Street Linkage
  Arts corridor down 12th New Q St development
- Park Block Linkages
  M street park blocks between 7th and 11th and 16th and 19th.
- Neighborhood Retail Center
  100,000 SF of retail Pedestrian-orientation Anchor grocery store Support for local businesses

Transit Framework
- Streetcar Route
- Downtown Bus Shuttle
- Multi-modal center
- Bicycle Framework

Eden Project Domes
Transportation Master Plan

KEY ELEMENTS:
- Transit Framework
- Bicycle Framework
- Auto Framework

Eden Project Domes
HTTP://UPLOAD.WIKIMEDIA.ORG/WIKIPEDIA/COMMONS/F/F2/EDEN_PROJECT_GEODESIC_DOMES_PANORAMA.JPG
Condition of Commercial / Industrial Structures

<table>
<thead>
<tr>
<th>Condition</th>
<th>#</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td>8</td>
<td>6.9%</td>
</tr>
<tr>
<td>Fair</td>
<td>32</td>
<td>27.6%</td>
</tr>
<tr>
<td>Good</td>
<td>58</td>
<td>50%</td>
</tr>
<tr>
<td>Very Good</td>
<td>18</td>
<td>12.5%</td>
</tr>
</tbody>
</table>

- Range from 1900s to 2003
- Industrial uses occupy 89.6 acres (22.2% of the area)
- Commercial occupies 5.7 acres (1.4% of the area)
- Incompatible land-use relationships
- Inadequate lot space and access for service vehicles

Housing Conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Single Family</th>
<th>Multi Family</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Condition      | #  | %  | #  | % | #  |%
| Very Poor      | 4  | 5% | 0  | 0%| 4  | 4% |
| Poor           | 28 | 35%| 1  | 4%| 28 | 28%|
| Fair           | 26 | 33%| 2  | 9%| 27 | 27%|
| Good           | 22 | 28%| 8  | 35%| 29 | 29%|
| Very Good      | 0  | 0% |12 | 52%| 12 | 12%|

- 40% ownership rate
- 101 average age of single family homes
- 103 Residential Structures, 310 Dwelling Units
  (80 single family homes, 230 units in 23 multi-family structures)
- 54 year average of multi family dwelling (10-117 range)

Eden Project Domes
Zoning

B-1: Local Business District
B-3: Commercial District
H-3: Highway Commercial District
I-1: Industrial District
O-1: Office District
P: Public Use District
R-3: Residential District
R-4: Residential District
R-5: Residential District
R-7: Residential District
R-8: Residential District
Ownership and Land Subdivision

- 350 separate ownership parcels
  (23 condominium units included)

- 147 separate ownership entities

- 63 parcels owned by public entities
  (88.9 acres, 34.2%)
  (City of Lincoln, Lancaster County, the Public Building Commission, Lincoln Electric System, Lower Plate South Natural Resources District, Salt Wahoo Watershed)

- 57 parcels owned by the railroad
  (57 acres, 22.1%)

- 230 parcels are owned by 137 private entities.
  (113.8 acres, 43.8%)

- Storm sewers and storm sewers are adequate for current use.

- Some infrastructure still in use is original to the area and dates from the late 1890's
Environmental Considerations

- Leaking Underground Storage Tanks (LUST sites)

- Soil, groundwater and air can be contaminated by many of the industrial operations in the area

Surface and Subsurface soils and shallow groundwater are commonly contaminated around refuelling areas in rail yards

- General railroad track areas are areas of contamination

- Highly probable contamination from early industrial development

  - Rail Road Roundhouse
  - Lincoln Gas Works
  - Lead & Color Works
  - Lincoln Tanning Co.
  - Grain Elevator

Environmental Considerations: West Haymarket Blight & Substandard Study Area

- Study Area Boundary
- Leaking Underground Storage Tank
- Railroad
- Areas of Potential Concern
- Streams

City of Lincoln
Urban Development GIS
Revised 6/2007
South Haymarket Master Plan

Dining / Entertainment
- 8th street
  Extending the South Haymarket District, south from the Harris Overpass

Marketplace Retail
- 100,00 SF of retail
  Neighborhood-serving retail uses
- Pedestrian-orientation
- Support for local businesses
- Anchor grocery store

Housing
- Vertical Mix
  Housing above retail and/or parking
- Transit
  Within walking distance
- Parking
  On site

High-density Housing
- Industrial or warehouse buildings
  Preserved and converted to a better use
- Underutilized or vacant parcels
  Infill, high density construction
- Amenities
  Planned transit, new parks, stores and services all within walking distance.
- Innovative housing opportunities
  Work-live and other housing types

Site Selection
The Site
**Development Goals**

**Mission Statement:**
To design an Educational, State of the art, sustainable Development that serves as a standard for future developments.

**Project:**
Redevelopment of South Haymarket

**Clients:**
City of Lincoln, Developer

**Site:**
South Haymarket

**Concept:**
Be flexible in terms of new technological advances and accommodate the Public into design alternatives to accompany such advances. Based on previous work, the tendency in market and client/architect values are looked at as a base to work from and enhance as deemed appropriate

<table>
<thead>
<tr>
<th><strong>Project Goals</strong></th>
<th><strong>Performance Requirements</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable Design</td>
<td>LEED Platinum-Energy “Negative - Neutral”</td>
</tr>
<tr>
<td></td>
<td>Passive House Design Standards</td>
</tr>
<tr>
<td>Flexible Program/Design</td>
<td>Green/Public Spaces</td>
</tr>
<tr>
<td></td>
<td>Multi-Use Spaces</td>
</tr>
<tr>
<td>Flexible Program/Design</td>
<td>Vegetable Gardens</td>
</tr>
<tr>
<td>High Tech/Adaptable Design</td>
<td>Water Conservation</td>
</tr>
<tr>
<td></td>
<td>Architectures that Attracts Users</td>
</tr>
<tr>
<td></td>
<td>New “Sustainable” development</td>
</tr>
<tr>
<td></td>
<td>Easy to Renovate/Change</td>
</tr>
<tr>
<td></td>
<td>Ability to Stay “Up to Date”</td>
</tr>
<tr>
<td></td>
<td>Progressive Design</td>
</tr>
</tbody>
</table>

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## Development Needs

### General

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Available Material</th>
<th>Ordinances</th>
<th>Climate</th>
<th>Contextual Significance</th>
<th>Circulation</th>
<th>Parking</th>
<th>Drainage</th>
<th>Noise</th>
<th>Structure</th>
<th>Infrastructure</th>
<th>Power Generation</th>
<th>Efficiency</th>
<th>Accessibility</th>
<th>Water Conservation</th>
<th>Food Production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Users

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Physically diverse</th>
<th>Students</th>
<th>Artisans</th>
<th>Citizens</th>
<th>Midwestern</th>
<th>Liberal Youth</th>
<th>Conservative majority</th>
<th>Looking for small growth</th>
<th>Saturdays and game days are influx days</th>
<th>Mainstream appeal</th>
<th>Walkable</th>
<th>Green open spaces</th>
<th>Handicapped accessible</th>
</tr>
</thead>
</table>

### Activities

<table>
<thead>
<tr>
<th>Outdoor Theater</th>
<th>Concerts</th>
<th>Dances</th>
<th>Socials</th>
<th>Farmers’ Markets</th>
<th>Film</th>
<th>Weddings</th>
</tr>
</thead>
</table>

### Socially/Psychologically

<table>
<thead>
<tr>
<th>Sustainably and self sufficient</th>
<th>Make it comfortable</th>
<th>Walkable</th>
<th>Point of interest in the city</th>
</tr>
</thead>
</table>

### Wants

<table>
<thead>
<tr>
<th>Flexibility</th>
<th>Adaptability</th>
<th>Progressive Design</th>
<th>Mixed Use</th>
<th>Sustainable Design</th>
</tr>
</thead>
</table>

### Organization

<table>
<thead>
<tr>
<th>Vehicle traffic</th>
<th>Parking</th>
<th>Circulation</th>
<th>Public Transportation</th>
<th>Bike Paths</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Pedestrian Traffic</th>
<th>Walking traffic</th>
<th>Destinational nodes</th>
<th>Walking Trails</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Infrastructure</th>
<th>Drainage</th>
<th>Power grid</th>
<th>Green Spaces</th>
</tr>
</thead>
</table>
In the revitalization of the South Haymarket, certain criteria became instrumental in the sustainable redevelopment of the area. With the history of the area and as the original heart of industry for the city, addressing the entire site as a brown field is imperative. The key issues with this site are the residual contamination left in place by passed occupants and the redevelopment requiring either capping or removal of contaminated soils. Capping is probably the most common means of dealing with existing contaminants, but it increases impervious surface conditions which makes storm management planning more important. Stormwater management must prevent the movement of contaminants and their migration to groundwater and surface waters.

Key criteria were identified in the redevelopment of the South Haymarket.
- Green clean up
- Reuse and recycling of construction and demolition materials
- Sustainable building design, and infrastructure design
- Energy efficiency
- Water conservation
- Renewable energy development
- Native landscaping

The benefits include:
- Reduce and delay stormwater runoff
- Enhance groundwater recharge
- Reduce stormwater pollutants
- Capture carbon output
- Reduce heat island conditions and reduce energy demand
- Improved air quality
- Additional recreational space
- Improved health
- Increased land value
When designing a building in this development and in other brown field sites, it is imperative that in the design of new work, the consideration of reuse of construction and materials is important. In assessing the site, the identification of Site contamination areas is imperative. The identification of drainage patterns and estimated flows and volumes is a key factor in designing a building and site in brown fields. The ability to couple with the amount of water that travels over sites will help in locating stormwater management controls. The south haymarket development will minimize runoff, prevent mobilization of contaminants and be conscious of maintenance.

Key site considerations:
- Difference between groups of contaminates to minimize risk.
- Separate stormwater and contaminated soils.
- Capture and reuse stormwater for non-potable uses
- Include soils and vegetation above a cap, if a cap is used.

With a variety of different contaminants possible in brown field sites, below is listed a few of the common contaminants and the danger they pose.

<table>
<thead>
<tr>
<th>Types of Contaminants</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salts</td>
<td>High</td>
</tr>
<tr>
<td>VOCs (BTWX, methane, naphthalene)</td>
<td>High/moderate</td>
</tr>
<tr>
<td>Metals (Pb, Ag, Hg, Cu, Ni, Cr, Zn, Cd)</td>
<td>Low/moderate</td>
</tr>
<tr>
<td>PAHs</td>
<td>Low</td>
</tr>
<tr>
<td>Pesticides/Herbicides (DDT, 2,4-d, methyl parathion)</td>
<td>Low/moderate</td>
</tr>
<tr>
<td>Bacteria</td>
<td>High</td>
</tr>
<tr>
<td>Nutrients (nitrates and phosphorous)</td>
<td>High</td>
</tr>
</tbody>
</table>
An important means of filtrating out contaminants as well as managing stormwater is using plant materials.

<table>
<thead>
<tr>
<th>Plant uses</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water uptake</td>
<td>Buffering strips</td>
</tr>
<tr>
<td>Stabilization</td>
<td>Vegetated trenches</td>
</tr>
<tr>
<td>Impeding flow</td>
<td>Biofiltration/rain gardens</td>
</tr>
<tr>
<td>Filtration</td>
<td>Vegetated swales and ditches</td>
</tr>
<tr>
<td>Infiltration</td>
<td>Stormwater ponds/wetlands</td>
</tr>
<tr>
<td>Nutrient uptake</td>
<td>Green roofs</td>
</tr>
<tr>
<td>Toxin uptake</td>
<td>Native plant reconstruction</td>
</tr>
<tr>
<td>Pollutant breakdown</td>
<td></td>
</tr>
<tr>
<td>Phytoremediation</td>
<td></td>
</tr>
</tbody>
</table>

While choosing plant material for the sites, other things that need to be considered are the environment and planting location as well as possible site issues.

**Site Issues in plant selection**

- Texture, organic content, PH
- Water levels, soil moisture
- Slopes
- Sun/ Shade

**Environmental planting issues**

- Flood depth, duration and frequency
- Low water levels
- Sediment loads
- Pollutants and toxins
- Nutrients
- Salt
- Turbidity
- Erosion
- Invasive plants
- Wildlife
## Water Harvesting Criteria

<table>
<thead>
<tr>
<th>Use</th>
<th>Min. Water Quality Guidelines</th>
<th>Suggested Treatment Options</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Potable indoor uses</strong></td>
<td>-Total coliforms: 0&lt;br&gt;-Fecal coliforms: 0&lt;br&gt;-Protozoan cysts: 0&lt;br&gt;-Viruses: 0&lt;br&gt;-Turbidity &lt; 1 NTU</td>
<td>-Pre-filtration - first flush diverter&lt;br&gt;-Cartridge filtration - 3 micron sediment filter followed by 3 micron activated carbon filter&lt;br&gt;-Disinfection - chlorine residual of 0.2 ppm or UV disinfection</td>
</tr>
<tr>
<td><strong>Non-potable indoor uses</strong></td>
<td>-Total coliforms &lt; 500 CFU per 100mL&lt;br&gt;-Fecal coliforms &lt; 100 CFU per 100mL</td>
<td>-Pre-filtration - first flush diverter&lt;br&gt;-Cartridge filtration - 5 micron sediment filter&lt;br&gt;-Disinfection - chlorination with household bleach or UV disinfection</td>
</tr>
<tr>
<td><strong>Outdoor uses</strong></td>
<td>-N/A</td>
<td>-Pre-filtration - first flush diverter</td>
</tr>
</tbody>
</table>

---

In selecting plants for bioretention and rain gardens in Nebraska, only certain plants can handle the varied climate. Included is a list of potential plants that could be used in the south Haymarket redevelopment.

**Herbaceous Perennials**

- Common Yarrow
- Leadplant
- Fragrant False Indigo
- Windflower
- American Columbine
- Spikenard
- Pale Indian Plantain
- Wild Ginger
- Swamp Milkweed
- Butterfly Milkweed
- Wood’s Aster Series
- Heath Aster
- Smooth Aster
- New England Aster
- Aromatic Aster
- Upland Aster
- Lady Fern
- Blue False Indigo
- Dwarf Blue False Indigo
- Purple Poppy Mallow
- Purple Prairie Clover
- Narrow-Leaved Coneflower
- Sweet Joe-Pye Weed
- Gateway Spotted Joe-Pye Weed
- Blanket Flower
- Wild Geranium
- Sneezeweed
- Ox-Eye Daisy
- Rough Blazing Star
- Prairie Blazing Star
- Cardinal Flower
- Great Blue Lobelia
- Ostrich Fern
- Wild Bergamont
- Smooth Beardtongue, Penstemon
- Prairie Phlox
- Obedient Plant
- Solomon’s Seal
- Virginia Mountain Mint
- Gray Headed Prairie Coneflower
- Golden Glow
- Wild Petunia
- Meadow Sage
- Cup Plant, Rosinweed
- Showy Goldenrod
- Tall Purple Rue
- Prairie Spiderwort
- Blue Vervain
- Common Ironweed
- Culver’s Root

**Grasses, Sedges, Rushes**

- Big Bluestem
- Sideoats Grama
- Blue Gama
- Bottlebrush Sedge
- Broom Sedge
- Common Fox Sedge
- Brown Fox Sedge
- Common Rush
- Path Rush
- Switch Grass
- Little Bluestem
- Indian Grass
- Prairie Dropseed

**Shrubs and Small Trees**

- Buttonbush
- Redtwig or Redosier Dogwood
- American Hazelnut
- Ninebark
- Elderberry
- American Cranberry Bush
New Bike Paths:

The integration of new bike paths throughout the new development allows for people more freedom to ride than what was originally proposed in the master plan. In integrating new safe bike paths it will encourage people to use their bikes more and cars less.

New Drainage System/ Green Spaces:

Due to the various environmental challenges that the South Haymarket proposes, the integration of new drainage systems and stormwater management was imperative. Integrating them into green spaces allows for a multifunctional system.
StreetScape Sustainability

The streetscape plays an integral part in the way that the overall development operates. A key component of the design is the placement of the bicycle lane, which is protected not only by the street plantings but also a lane of parallel parking. The use of parking, street plantings and bike lanes to buffer the sidewalk from the street allow for a more pedestrian friendly streetscape.
Streetscape Sustainability

The streetscape plays an integral part in the way that the overall development operates. The street plantings serve a dual purpose; they can be harvested periodically to be used as bio mass, but serve as a means for water filtration and drainage.
Development Application:
Implementing this system on the South Haymarket serves as a pilot program for the overall city implementation. The difference in this implementation is that instead of different areas of the city being designated a specific criteria in which they will excel, individual buildings will be charged with this duty. Each building will be expected to excel in their criteria in order to make up for the possible deficiencies that other buildings in the development may have.
- 39 Broadway theaters

- Estimated 1,807 Not-For-Profit Theaters in 2010
  - 163,000 performances
  - 31,000,000 people attended

- Energy Independence and Security Act (EISA)
  - (phasing out of incandescent lamps by 2014)

- Each lamp is still incandescent
  - (lose 90% of energy to heat)
  - Wattage varies from 575w to 1K

- Strike:
  - Deconstruction of each set on a regular basis demands for storage or disposal.

- Storage
  - Costumes, Lighting, Audio

- Phantom of the Opera became the longest running Broadway musical January 8, 2006 with 7,486 performances.
Light Plot for "Mid Summer Nights Dream", Kimbal Recital Hall, Lincoln, NE.

That Untraveled Land at CalArts (2006)

- Sound plot at peak draw 15kw
- Projectors (9) pull 275w
- Lighting plot 279.57 kw
- $1,347,527.40 on a Solar Array
- 10.88 metric tons of CO2
  25.29 barrels of gasoline,
  Emissions of two passenger cars
  Yearly energy consumption of an American home
  (9 acres of pine to offset)
- If run at full intensity it would cost $2,739.79 per hour to run
- HVAC compensate for 877,849.80 btu/hour
**Concert Hall**

This building type traditionally houses classical orchestral and choral music as well as jazz and pop/rock music on occasion. Traditionally, there is a resident orchestra who uses it exclusively or seasonally. It can also serve as a touring facility for other orchestras or groups as well as for promotional organizations and events. The main auditorium is traditionally in a proscenium configuration and sometimes has an orchestra pit depending on the venue.

**Specifics**
- Acoustics are particularly important.
- Portable band shell permanent or collapsible
- Choral risers

**Types of Performances**
- Orchestras
- Choirs
- Chamber music
- Jazz ensembles
- Dance
- Rock Concerts (on occasion)
- Corporate events (on occasion)
- Operas (on occasion)
THEATER

Generally has a resident drama company who perform in repertory, or repertoire as well as plays host to visiting companies. Theaters come in a variety of configurations such as black box, proscenium and thrust just to name a few. Because of the variety of performances that happen in the space, an orchestra pit and trap doors are commonly found in theaters. There also tends to be large wing spaces to store scenery and actors during a performance.

SPECIFICS

- Lots of wing space
- Ample batons in the fly system

-TYPES OF PERFORMANCES

Straight plays
Musicals
Stage readings
Dance
Operas (on occasion)
Corporate events (on occasion)
Dance

Professional resident dance company operates out of here, either in repertory or repertoire as well as playing host to touring companies. These spaces are traditionally set up in a proscenium configuration. Unlike opera or theater, stage floors for dance should not be fitted for traps. While they traditionally do not have traps, they do generally include an orchestra pit.

Specifics
- Stage floor construction
  (On pointe dancer exerts 360 per square inch, bare foot modern dancer exerts 130, with sneaker exerts 40)
- No floor obstructions
  traps
  lifts
  raised floor pockets

Types of performances
  Modern Dance
  Ballet
  Movement pieces
  Opera
  Choral Concerts
  Corporate events

“Hamlet”, Black Box Theater, UNO, Omaha, NE

“Susannah”, Des Moines Metro Opera, Blank Theater, Indianola, IA
Touring Houses

Houses drama and musical productions usually for long runs over several months. They usually host premiers or promote new productions of plays and musicals. With lots of turn around in the spaces of a touring house, it is imperative that the spaces are able to accommodate the variety of different demands that an incoming group might have.

Specifics
- Extra distribution boxes for power
- Large number of dressing rooms
- Minimum of two loading docks

Types of performances
- Ballet
- Modern Dance
- Movement pieces
- Orchestras
- Choirs
- Chamber Music
- Jazz ensembles
- Rock Concerts
- Straight Plays
- Musicals
- Corporate events

LIED Center, main auditorium, Lincoln, NE

“Sweet Dreams” Howell Theater, UNL, Lincoln, NE
OPERA

Professional resident company operates out of here, either in repertory or repertoire as well as playing host to touring companies. Sometimes it is exclusively opera but can also be coupled with ballet. These spaces are traditionally a proscenium configuration, though there tend to be some variations. Almost all opera houses have orchestra pits. Some stages terminate when they reach the orchestra pit; others will bridge the pit and have a playing circle to bring the singers closer to the audience.

Specifics

- Acoustics are particularly important in the configuration of the space
- Slightly taller proscenium Arch.
- Ample sound jacks for monitors

Types of performances

- Operas
- Vocal Concerts
- Musicals
- Orchestras
- Jazz ensembles
- Ballet

“McBeth”, Des Moines Metro Opera, Blank Theater, Indianola, IA

“Rigoletto”, Kimbal Recital Hall, UNL, Lincoln, NE
Convention Center/Arena

Large facilities for large scale events and other spectacles such as opera, musicals, rock concerts. It can also be rented out by commercial organizations who either have one time events or promote events as part of a tour. Traditionally, this building type houses the largest variety of events. Generally an open plan that can be adapted to a variety of seating arrangements and special events.

Specifics
- Architecture that allows for stage rigging to be attached to it.
- Large loading areas.
- Variety of ties into the electrical system
  - 2 phase and 3 phase
- Flexible seating arrangements

Types of performances
- Rodeos
- Corporate events
- Rock Concerts
- Musicals
- Sporting events
- Conventions
Charles Wyly Theater

Though not a sustainable case study in the traditional sense, this building's ability to literally transform its space into a variety of configurations allows for the company to get the most use of it. The ability of the space to change from anything from a traditional proscenium to a flat floor configuration allows for the company to play host to a variety of different clients with a variety of different needs. An interesting approach that was taken in designing this project was that they took a no prototyping approach. In response to this, they reapplied existing technologies to implement this unique design.

- Dallas, TX
- 80,300 ft²
- $338 million
- 575 seat “multi-form” theater

- Adaptable
  - Proscenium
  - Thrust
  - Flat floor
  - Black box

- No prototyping
  - Reaplication of existing technologies

Charles Wyly Theater
http://www.rex-ny.com/media/20091120111848_REX_Wyly_01.jpg

Charles Wyly Theater Configuration Diagram
http://www.rex-ny.com/media/20091120113406_REX_Wyly_11.jpg
Gerding Theater

The highest LEED rated case study with Platinum was a renovation of a 1891 armory. This project took advantage of its location by using the public transportation and a nearby park with native plants to add LEED points, though they did make key material selections in the renovation of the building. The most progressive thing that the project did was using rainwater instead of potable water and thus reducing water use by 88%.

- Portland, OR
- Renovation of a 1891 armory
- 55,000 ft2
- 38.7 million project
- 600 seat main stage
- 200 seat studio theater
- LEED Platinum

- Sustainable Practices
  - Material selection
  - Accessible by public transportation
  - Nearby park with native plants
  - Using rainwater instead of potable water
  - Reduced water use by 88%
David L Lawrence Convention Center

When it first opened in 2003 the David Lawrence Convention Center was the first and largest green building of its kind in the U.S. Today it is the sixth largest green building. Though it achieved LEED Gold, the convention center really only implemented the bare minimum of sustainable practices being natural lighting, natural ventilation, water reclamation, comprehensive recycling program, sustainable site, materials, and resources as well as indoor environmental quality. What can be taken away from this project is that even the most basic sustainable practices can be used on a large scale.

-Pittsburgh, PA
- Total Square Footage 1,450,000 ft²
- 51 meeting rooms
- 5 exhibit halls
- 2, 250 seat lecture halls
- 37 loading docks
- $373 million
- LEED Gold Certification
- First and Largest Green Building of its kind (2003)

-Sustainable Practices
  - Natural lighting
  - Natural ventilation
  - Water reclamation
  - Comprehensive recycling program
  - Sustainable site, materials, and resources
  - Indoor environmental quality
Las Palmas Water Theater

Though not a built project, the Las Palmas Water Theater was designed to mimic the way the Namibian fog-basking beetle creates its own fresh water. The design looked to take advantage of the sunny conditions, steady wind direction and cold seawater that the site provides in order to create large amounts of desalinated water for the town of Las Palmas. The design set the evaporators and condensers as the backdrop to the outdoor amphitheater. “What might normally have been a mundane piece of infrastructure is elevated to the level of sculpture.”
-exploration-architecture.com
Program Goals

Mission Statement:
To design an Educational, State of the art, sustainable Performing Arts Center that serves as a keystone for a sustainable development.

Building:
Performing Arts Center

Clients:
Lincoln Community Playhouse
Angels Group
Lincoln Symphony Orchestra

Site:
South Haymarket

Concept:
Be flexible in terms of technological advances and accommodate the client with design alternatives to accompany such advances. Based on previous work, the tendency in market and client/architect values are looked at as a base to work from and enhance as deem appropriate

<table>
<thead>
<tr>
<th>Project Goals</th>
<th>Performance Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable Design</td>
<td>LEED Platinum-Energy “Negative-Neutral”</td>
</tr>
<tr>
<td>Flexible Program/Design</td>
<td>Passive House Design Standards</td>
</tr>
<tr>
<td>High Tech/Adaptable Design</td>
<td>Green/Renewable Materials and Concepts</td>
</tr>
<tr>
<td>Large/Expandable Stage and Seating</td>
<td>Multi-Use Spaces</td>
</tr>
<tr>
<td>Architecture that Attracts Users</td>
<td>New “Sustainable” development</td>
</tr>
<tr>
<td>Easy to Renovate/Change</td>
<td>Ability to Stay “Up to Date”</td>
</tr>
<tr>
<td>Road House Capable</td>
<td></td>
</tr>
</tbody>
</table>
Lincoln Community Playhouse:

The mission of the Lincoln Community Playhouse (LCP) is to create and promote quality theatrical experiences that meet the needs of the Lincoln area. LCP achieves its mission by providing opportunities for participation by children, youth, and adults, a variety of opportunities for volunteerism, a variety of opportunities for education regarding the theatre, and by promoting a theatre that is entertaining and affordable to a multi-faceted audience.

www.lincolnplayhouse.com/

Angels Theater Company:

The Mission of the Angels Theatre Company is to provide opportunities for Lincoln talent, to nurture original works, to promote and encourage professional artistic growth, and to allow company members access to a community of supportive individuals.

http://www.angelscompany.org/

Lincoln Symphony Orchestra:

Through the performance and advancement of symphonic music, Lincoln’s Symphony Orchestra will educate, entertain and enrich current and potential audiences.

http://www.lincolnsymphony.org/
Program Needs

General

Capacity
Available Material
Ordinances
Climate
Contextual Significance
Circulation
Parking
Drainage
Noise
Structure
Performance
Funding
Efficiency
Accessibility

Characteristics

Physically diverse
Educated/not educated
Students
Artisans
Citizens
Traveling companies
Midwestern
Conservative majority
Looking for small growth
Saturdays and game days are popular
Influx days
Mainstream appeal
Handicapped

Socially/Psychologically

Make it sustainable and self sufficient
Make it comfortable
Make it easy to use
Make it a center point

Wants

A state of the art facility
Flexibility
Adaptability
Progressive Design
To break the antiquated stigma of surrounding architecture

Organization

Front House
Public space and lobby

Back of House
Private staging

Chamber
Where the public meets the stage
Activities

Lecture classes
Dance Shows
Theater
Concerts
Dances
Socials
Meetings
Film
Weddings
Reception Hall
Gallery

Spaces and Specific Requirements

Staff

Secretary
Theater Manager/Publicity
Bookkeeper
2 Scene Technicians
2 Costume Shop Technicians
Light Technician

Students

15 Students (Varied Age)
### Program and Square Footage

<table>
<thead>
<tr>
<th>Room</th>
<th>Square Footage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Room</td>
<td>210 sq ft</td>
</tr>
<tr>
<td>Classroom</td>
<td>500 sq ft</td>
</tr>
<tr>
<td>Traditional Classroom</td>
<td>340 sq ft</td>
</tr>
<tr>
<td>Conference Room</td>
<td>150 sq ft</td>
</tr>
<tr>
<td>Offices</td>
<td>150 sq ft</td>
</tr>
<tr>
<td>Mechanical Room</td>
<td>600 sq ft</td>
</tr>
<tr>
<td>Main Office</td>
<td>350 sq ft</td>
</tr>
<tr>
<td>Lighting Shop</td>
<td>700 sq ft</td>
</tr>
<tr>
<td>Prop Shop</td>
<td>200 sq ft</td>
</tr>
<tr>
<td>Scene Shop</td>
<td>1200 sq ft</td>
</tr>
<tr>
<td>Loading Dock</td>
<td>500 sq ft</td>
</tr>
<tr>
<td>Paint Area</td>
<td>350 sq ft</td>
</tr>
<tr>
<td>Ticket Office</td>
<td>120 sq ft</td>
</tr>
<tr>
<td>Costume Shop</td>
<td>1000 sq ft</td>
</tr>
<tr>
<td>Rehearsal Space</td>
<td>2200 sq ft</td>
</tr>
<tr>
<td>Dressing Rooms</td>
<td>750 sq ft</td>
</tr>
<tr>
<td>Restrooms</td>
<td>TBA</td>
</tr>
<tr>
<td>Locker Room</td>
<td>750 sq ft</td>
</tr>
<tr>
<td>Sound Storage</td>
<td>200 sq ft</td>
</tr>
<tr>
<td>Lobby</td>
<td>2100 sq ft</td>
</tr>
<tr>
<td>Concessions</td>
<td>1000 sq ft</td>
</tr>
<tr>
<td>Proscenium Theater</td>
<td>6600 sq ft</td>
</tr>
<tr>
<td>Balcony</td>
<td>1200 sq ft</td>
</tr>
<tr>
<td>Black Box Theater</td>
<td>2800 sq ft</td>
</tr>
<tr>
<td>Lighting and Sound Booth</td>
<td>150 sq ft</td>
</tr>
<tr>
<td>Orchestra Pit</td>
<td>400 sq ft</td>
</tr>
<tr>
<td>Storage</td>
<td>2000 sq ft</td>
</tr>
<tr>
<td>Janitorial Closet</td>
<td>80 sq ft</td>
</tr>
<tr>
<td>Crying Room</td>
<td>200 sq ft</td>
</tr>
<tr>
<td>Optional Program</td>
<td></td>
</tr>
<tr>
<td>Restaurant</td>
<td>4300 sq ft</td>
</tr>
<tr>
<td>Retail</td>
<td>99000 sq ft</td>
</tr>
<tr>
<td>Gallery</td>
<td>7100 sq ft</td>
</tr>
</tbody>
</table>
Building Relations

Links created by buildings for the performing arts on a city scale. Specifically in relation to tourism, arts festivals and conferences.
Flow Chart

Scene shop
  - loading dock
  - Stage
    - orchestra pit
    - lobby
  - ticket office

- paint room
  - catwalk
  - sound booth
  - lighting booth
  - spot booth
  - concessions
  - coat check
The implementation of the new sustainability matrix on a building scale is imperative, using a performing arts center as an example shows that it is applicable to almost any building type. In the design of the performing arts center certain criteria from the sustainability matrix were identified and implemented in the final design. In accordance to the way the matrix is meant to be used, at least one criteria from each category was used.
Mission Statement:
The dependency on fossil fuels has grown and grown over the years, and there is no quick fix. It is generally agreed that sustainability is a good idea. Americans have made many changes in their lives in order to be more sustainable, but one major category remains untouched. The way in which cities are planned and developed has remained unchanged. The days of architecture being an object in space is no longer viable. It is imperative for architecture to give back to not only the environment but the community.

Site:
South Haymarket

Clients:
Lincoln Community Playhouse
Angels Group
Lincoln Symphony Orchestra

Building:
Performing Arts Center

Program
A
B
C

Scale: 1/16"=1'

Fruits/Vegetables
Geothermal
Bioswale/Rain Garden
Solar
Mission Statement:
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Site:
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Building:
Performing Arts Center

Program
A
B
C

Rain/graywater Collection
Porous pavement
Yard/Bio Waste
Green Roof

Scale: 1/16"=1'

Site Plan
Mission Statement:
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Site:
South Haymarket

Clients:
Lincoln Community Playhouse
Angels Group
Lincoln Symphony Orchestra

Building:
Performing Arts Center

Program

**Public**
1. Ticket Office
2. Restrooms
3. Lobby
4. Concessions

**Support**
15. Storage
16. Mechanical Room
17. Janitorial Closet
18. Green House
19. Lighting Shop
20. Scene Shop
21. Paint Room
22. Loading Dock
23. Costume Shop
24. Locker Room
25. House Storage
26. Sound Storage
27. Lighting and Sound Booth

**Chamber**
12. Black Box Theater
13. Proscenium Theater
14. Concert Hall

**Misc.**
11. Main Office

**Back of House**
11. Ticket Office
2. Restrooms
3. Lobby
4. Concessions
10. Offices
11. Main Office
12. Black Box Theater
13. Proscenium Theater
14. Concert Hall
15. Storage
16. Mechanical Room
17. Janitorial Closet
18. Green House
19. Lighting Shop
20. Scene Shop
21. Paint Room
22. Loading Dock
23. Costume Shop
24. Locker Room
25. Sound Storage
26. Lighting and Sound Booth
27. Lighting and Sound Booth

Scale: 1/32" = 1'
Mission Statement:
The dependency on fossil fuels has grown and grown over the years, and there is no quick fix. It is generally agreed that sustainability is a good idea. Americans have made many changes in their lives in order to be more sustainable, but one major category remains untouched. The way in which cities are planned and developed has remained unchanged. The days of architecture being an object in space is no longer viable. It is imperative for architecture to give back to not only the environment but the community.

Site:
South Haymarket

Clients:
Lincoln Community Playhouse
Angels Group
Lincoln Symphony Orchestra

Building:
Performing Arts Center

Program:
A
B
C

Final Design
Building Sustainability Systems
Amphitheater Sustainability

The upper half of the amphitheater doubles not only as a place for water collection and filtration but also as a garden for food production. The water collected can be used not only for the garden or green house but also in the other building facilities as grey water. The plant matter produced can also be harvested either as compost or bio mass.
Main House Sustainability

The Southern facade of the loft space is covered in photovoltaics which will help to balance out the buildings over all energy consumption. The entire southern facing facade of the building is covered in photovoltaics, and should produce 215,274 kWhr/year, which equates to about $25,833 in electricity a year. The intensive roof like much of the rest of the building, both counters the heat island effect, as well as collects and filters water for the building. The plant mass that is produced here can be used either as compost to help in food production in the green house of in the gardens in the amphitheater, or harvested to be used as bio mass. The southern face of the fly loft also works as a heat exchange for the building, allowing the building to heat and cool itself more efficiently.
Concert Hall Sustainability

The concert hall's green roof not only serves as an intensive one, but as a means to capture and filter rain water for use in other parts of the building. The plant mass produced on the roof can either be harvested as bio mass, or as compost in either the greenhouse or in the amphitheater. The double facade works to funnel super heated air in order to cool the facade of the building.
Skin Sustainability

The double skinned facade funnels the super heated air across the facade cooling it while at the same time, harvesting the super heated air in the building's green house. The green house will produce food for the restaurant as well as for concessions within the building. The green house waste can also be used either as biomass or compost for future food production. Also integrated into the double skin facade is a series of rain gutters, which collect the rain water to be used not only in the building's intensive green roofs, green house but also as grey water in the buildings facilities.
MAIN ENTRANCE


Lincoln Downtown Master Plan, City of Lincoln, September 2005


Poykko-Post, Julio and James J Caruso, West Haymarket Area Blight and Substandard Determination Study Lincoln, Lancaster County Nebraska. June, 2007


Simpson, Scott. “Going Green: Taking the Long View” in Design Intelligence, July/August 2011. Print


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